

Engineering Conferences International ECI Digital Archives

Composites at Lake Louise (CALL 2015)

Proceedings

Fall 11-11-2015

Mechanisms and models for SiC fiber strength changes after oxidation in air and steam

Randall Hay

Follow this and additional works at: http://dc.engconfintl.org/composites_all



Part of the [Materials Science and Engineering Commons](#)

Recommended Citation

Randall Hay, "Mechanisms and models for SiC fiber strength changes after oxidation in air and steam" in "Composites at Lake Louise (CALL 2015)", Dr. Jim Smay, Oklahoma State University, USA Eds, ECI Symposium Series, (2016). http://dc.engconfintl.org/composites_all/92

This Conference Proceeding is brought to you for free and open access by the Proceedings at ECI Digital Archives. It has been accepted for inclusion in Composites at Lake Louise (CALL 2015) by an authorized administrator of ECI Digital Archives. For more information, please contact franco@bepress.com.

The strengths of Hi-NicalonTM-S SiC fibers were measured after oxidation in wet air, dry air, and Si(OH)₄ saturated steam between 600° and 1400°C. Amorphous and crystalline SiO₂ scale thickness was measured by TEM. Deal-Grove kinetics for oxidation and Kolmogorov-Johnson-Mehl-Avrami kinetics for crystallization were determined. Fibers oxidized in steam much more rapidly than in dry or wet air. Hi-NicalonTM-S fibers were completely oxidized to crystalline SiO₂ after 100h at 1100°C. The corresponding scale thickness for dry air was 1.3 μm. Fiber strength changes after oxidation in dry and wet air were similar, but with some subtle distinctions. Fiber strength increased by approximately 10% for scale thickness up to ~100 nm, and decreased for thicker scales. Fibers oxidized in wet air were slightly weaker than those in dry air, and there were several outliers for fibers oxidized in wet air at 800 - 900°C with significantly lower strength. These outliers are attributed to intermediate temperature subcritical crack growth during oxidation. All other fibers with significantly degraded strength had crystallized or partially crystallized scales. The strength changes that occur during oxidation are modeled using oxidation and scale crystallization kinetics, growth stresses that develop in scales from volume expansion during oxidation, and thermal stresses that develop in scales from thermal expansion mismatch and phase transformations in crystalline scales. Strength modeling uses the superposition of stress intensity factors for the residual stress field on the stress intensity factors for a critical flaw without residual stress. The models are sensitive to the fraction of the scale that is crystallized. Modeling results are presented and discussed. Degradation and strength enhancement mechanisms in SiC fibers after oxidation are also discussed.